

Chelsea Times-Marshall

Pilot Study: Measuring the Effects of Center of Gravity Shift on Postural Stability

Dr. Millard Reschke

Johnson Space Center

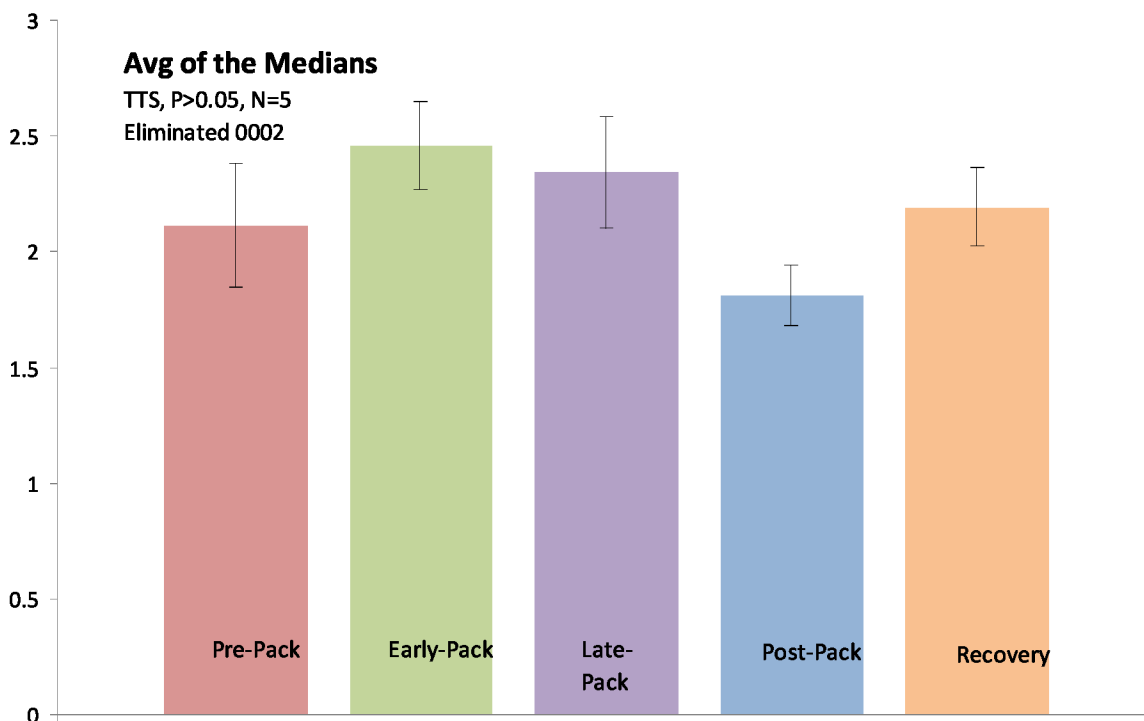
Abstract:

It has been shown that astronauts returning from space often experience postural instability due to the stimulus rearrangement of the visual, vestibular, and proprioceptive systems. However, postural control may also be influenced by the head-ward shift in their center of gravity (CG) that occurs as a result of the expansion of their spinal column by as much as two inches during long duration space flight, as well as the CG shift that occurs from the Life Support Pack on the extra-vehicular activity (EVA) suit. This study investigated the effect on postural stability after (1) an immediate shift in the CG towards the head, (2) a 30 minute adaptation to the shifted CG, and (3) immediate shift of the CG back to normal, accomplished by donning and removing a modified backpack. We hypothesized that at each immediate shift in CG, postural performance will be compromised.

Introduction:

Postural instability plays a major role in an astronaut's functionality and performance after spaceflight which is why it is a frequently monitored issue today. However, what is not being monitored is what role, if any, a shift in an astronaut's center of gravity (CG) plays in postural stability. With future extra vehicular activities (EVA) planned on the lunar surface, this question needs to be answered. The Manned Maneuvering Unit or MMU, weighing in at 255 pounds on Earth and 45 pounds on the moon is both lifted and forward on the wearer's back. In micro-gravity space, movement of astronaut's limbs cause changes in MMU posture, resulting in great offsets to correct direction and make a

great effect on MMU's manipulation performance. This unit inevitably lifts one's center of gravity and causes them to become unsteady with a less stable gait due to the sudden raised center of gravity. NASA retired the unit in the 80's with the 10th shuttle mission; however the new unit, Simplified Aid for EVA Rescue (SAFER) has now been introduced. SAFER has only two advantages when compared to the MMU, 1) it is more convenient of a size and weight and 2) ideal for an astronaut rescue device outside the Space Station. However it still poses the posture change as it has a forward and lifted positioning which did nothing to aid space flight except provide more storage space and less weight aboard the shuttle. Our study attempted to mimic the change in CG experienced by astronauts as a result of the EVA suit. Furthermore, our study sought to answer the query: Does adaptation and the sudden removal of the displaced CG have postural consequences? Below is the table we constructed to demonstrate the trend which occurred in our data. The general trend indicated that subjects were more stable after adapting to the backpack, which consequently went against our hypothesis of their posture being comprised due to the pack's removal.



Goals and Purpose:

The purpose of this pilot study was to mimic a change in CG that astronauts may experience during planetary EVA's. By donning and removing a modified backpack, we could provide subjects with an immediate shift in CG, and collect data on them to measure their postural performance. The project and its results can be used to infer that once astronauts return to their lunar habitat following an EVA, they may have less risk of injury from falling. Although the data we collected disproved the initial hypothesis that immediate shifts in CG would cause postural instability, it did show that subjects took less time to return to their upright stance after removing the backpack following the post adaptation period.

Impact of the MUST Internship on My Career Goals:

The MUST program has not only allowed me first-hand experience in my major, it has allowed me to gain a greater understanding of what it takes to finish a project from its conception to its commencement in a timely and orderly fashion. Everything that was done, no matter how diminutive, had a purpose. Whether it was constructing a graph or simply observing a subject during preliminary testing, every piece of information plays a role when attempting to conceptualize a new idea, as NASA is able to do to keep themselves on the forefront of research. This work ethic that I was introduced to while at NASA has helped to apply it to my future career goals. This experience had made me aware of what I have to do to obtain my long-term objectives which include, but are not

limited to, graduating medical school, becoming a doctor, and conducting research. With NASA's far-reaching mission I am well aware that nothing is unattainable. Now, more than ever, I feel more than confident in pursuing my future STEM-related endeavors thanks to my NASA internship.